

REMARKS

Claims 1-3, 5-7, and 9 were rejected for anticipation in view of Marko. Claims 4 and 8 were rejected as unpatentable over Marko in view of Carlson. Claim 10 was rejected as being unpatentable over Marko in view of Ishizu. Claim 11 was rejected as being unpatentable over Marko in view Ishizu in view of Downey. Applicant requests reconsideration. Independent claims 1 and 10 were amended to recite that the lead and lag signals are generated within a window period of time referenced to the adjusted timing pulses.

Ishizu and the prior art teach that a comparator can be used to detect zero crossings. Downey and the prior art teach that various modulation methods can be used to generate self-clocking baseband signal waveforms encoding a digital bit stream. Carlson and the prior art teach that windows can be used to count transitions therein and that that count can be compared to a predetermined value. The use of zero crossings, modulation methods, windows, and counters are all well known in the art. Ishizu, Carlson, and Downey teach well-known prior art components. However, none of these references teach lead and lag detection of transitions over a window period. The present invention enables more precise timing and faster tracking of the timing of a baseband signal encoding a digital bit stream.

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1 Marko teaches an accumulator for adjusting a clocking signal as
2 part of a timing recovery loop. However, Marko does not anticipate
3 because Marko uses phase detection, which teaches away from the
4 present invention as strong evidence of nonobviousness. The
5 combination of Marko with Ishizu, Carlson, and Downey does not
6 reach the claimed invention. In Marko there is a recovery time loop
7 that is designated by items 902, 904, 906, 908, 910, 916, 926, 932
8 shown in detail in Figure 9A. In the present inventions, the timing
9 recovery loop includes items 10, 12, 16, 18, 20, 22, 26, 14, and
10 11. These two loops particularly differ in that Marko generates
11 early and late signals based upon phase detection, whereas, the
12 present invention generates lead and lag signals based upon window
13 detection. Both Marko at 902 and the present invention at 10 have a
14 baseband signal input encoding a digital bit stream. Both Marko at
15 992 and the present invention at 15 provide a digital bit stream
16 output. The objects are the same. Of course, the fundamental
17 difference is how adjustments are made to the clocking signal for
18 precisely detecting the digital bit stream.

19
20 The primary object of a timing recovery loop is to provide a
21 timing signal that can be used to clock a baseband signal encoding
22 a digital data stream into that digital data stream. The original
23 baseband signal is self-clocking in that it contains transitions,
24 high to low, and low to high, that define bit periods and that can
25 be used to generate and adjusting the clocking signal for tracking
26 the timing of the baseband signal having early and late baseband
27 transitions.
28

1 In the present invention, a baseband waveform 10 is clocked
2 using a data detector 11 to generate adjusted timing pulses 14 used
3 to generate the digital bit stream 15. In Marko, at Figure 5, the
4 designated as prior art includes a recovered clock 502, which is a
5 baseband clock signal, includes recovered data 504, which is a
6 baseband signal encoding the digital bit stream, and center bit
7 sampled data 506, which is the desired digital bit stream. The
8 "early transition" of the leading edge of BIT1 shows that the
9 recovered data edges are early or late by a phase in reference to
10 the recovered clock. In Figure 6 of Marko, the recovered clock
11 signal 604 is compared with recovered data 606. The recovered clock
12 refers to early and late transitions of the clock 604 relative to
13 the recovered data 606 having late and early transitions.

14

15 Marko uses an early and late accumulator 912 for counting early
16 and late signals 908. The accumulator counts early and late phase
17 detections over an accumulation time. When accumulator counts to
18 twenty, for example, meaning twenty more early transitions than
19 late transitions, the clock timing is adjusted and the accumulator
20 is cleared. Thus, the accumulation time is not fixed but variable
21 depending on rates of early and late phase detections. The sign
22 indicates whether there are more early detections or more late
23 detections. The accumulator sign is used to then adjust the
24 clocking signal in increments of 1/32 of a bit period, being the
25 phase detection period.

26

27 Marko uses a sign signal 914, a frequency offset correction
28 circuit 916, a multiplexer 926, a reference clock 934, and a

1 divider 932 for generating a narrow BW recovered clock. The present
2 invention uses a count magnitude generator 18, a count sign clipper
3 20, a threshold comparator 22, a timing pulse delay adjustor 26,
4 reference timing pulses 26, and a timing pulse delay 34 for
5 generating adjusted timing pulses 14. While the specific means are
6 difference, both Marko and present invention provide timing signals
7 used to clock the baseband signal encoding the digital bit stream
8 for generating the digital bit streams. However, the benefit of the
9 present invention lies in the new way of adjusting the timing
10 signals derived from the original baseband signal. This difference
11 is made clear by understanding the difference in function between
12 Marko's phase detector 906 and applicant's comparator 12.

13

14 Marko's phase detector generates early and late signals
15 respectively indicating when baseband transitions are early or late
16 relative to the clocking signal. When the clocking signal
17 transitions are early or late by at least that phase amount of
18 time, with is 1/32 of a bit period, early and late phase detections
19 are accumulated to a predetermined count when the clocking signal
20 is adjusted. The clocking signal transitions are early or late
21 relative to baseband detected transitions when early or late by a
22 predetermined bit period phase amount, which is a fraction of a bit
23 period amount of time as a clock phase. Hence, Marko uses a phase
24 detector, for example, by a 1/32 phase of a bit period. The early
25 and late accumulations can randomly walk indefinitely without
26 adjusting the clocking signal as long as early and late detections
27 do not exceed a predetermined amount of the early or late phase
28 detections as accumulated by the accumulator. As such, Marko

1 teaches transition phase detection, in fractional bit period
2 phases, for each bit period, for generating early and late signals,
3 for each bit period, accumulated over an indefinite number of bit
4 periods of time, for adjusting the clocking signal by that
5 fractional bit period.

6

7 The present invention uses a random walk counter 16 for counting
8 +1 lead and -1 lag signals derived from transitions occurring
9 within a window period of time. The lead and lag signal are
10 accumulated. When the accumulated number early or lag signals
11 reaches a threshold value, the adjusted timing pulses are adjusted.
12 The accumulation of leads and lags is over a plurality of bit
13 periods. Significantly, the present invention determines lead or
14 lag transitions using a window period of time, so that, regardless
15 of how small is the early or late baseband transitions to the
16 adjusted clocking signal, there may be a lead or lag, as nothing is
17 really perfect. That is, even under very accurate perfect timing,
18 the window can be used for generating lag and lead signals, which
19 is not limited by how much time in bit period phase are the
20 transitions early or late relative to the adjusting timing pulses,
21 such as by phase detection in Marko.

22

23 The window may be a 1/2 of a bit period, one bit period, or a
24 plurality of bit periods. However, the lead and lag signals are
25 generated over a window time period. The window time size can vary,
26 but preferably is less than one bit period. However, as soon as a
27 lead or lag signal is detected within the window, the counter 16 is
28 immediately updated, and the adjusted timing pulse can be

1 immediately adjusted depending on the threshold value. This
2 provides for adjusting the adjusted timing pulses even when the
3 transitions are early or late less than a predetermine amount of
4 time corresponding to a bit period phase as detected in Marko.
5

6 The present invention teaches lead, none, and lag signal
7 detection by comparison over a window period of time with the lead
8 and lag signals being accumulated over a plurality of bit periods
9 for adjusted the adjusted timing pulses. Marko teaches transition
10 phase detection, in fractional bit period phases, for each bit
11 period, for generating respective early and late signals, for each
12 bit period, accumulated over an plurality of bit periods of time to
13 a predetermined maximum value, for adjusting the clocking signal by
14 that fractional bit period. Marko relies upon phase detection of
15 early and late transitions for accumulating phase errors over a
16 plurality of bit periods. The present invention relies on window
17 transition comparison of early and late transitions as lead and lag
18 signals accumulated over a plurality of bit period of time to a
19 predetermined threshold value, for adjusting the clocking signal.
20 This difference is significant. In Marko, the minimum timing error
21 is the phase amount, which is preferably stated as 1/32 bit period,
22 and the accumulator count, which is preferably stated twenty, both
23 of which mean that 1/32 bit period error is multiplied by the
24 twenty accumulator count for providing a total error accumulation
25 of 20/32 of a bit period. This is large, imprecise, and slowly
26 reached. Marko must have at least this amount of error before an
27 adjustment will be made.

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1 In Marko, the transitions must be off-center at least a phase
2 amount of time. This phase amount of time is a minimum error amount
3 required before any adjustment in the accumulator, which must count
4 up before adjusting the clock signal. When the transitions are off
5 less than that this phase amount of time, no early and late signals
6 are generated, and no accumulation occurs, and no timing adjustment
7 is made, yet, even smaller offsets in transition phase can degrade
8 the clock timing over time, and hence, degrade data detection.
9 However, when transitions are determined to be leads or lag, by
10 virtue of merely within a window period of time, as in the present
11 invention, then each transition may cause a lead or lag signal,
12 particularly even when the transition error offsets are less than
13 Marko's phase. As such, the present invention will start the
14 accumulation of "apparent" timing error offsets and will then
15 adjust the adjusted timing pulses, even when the transition error
16 offsets are practically insignificant when much less than Marko's
17 phase error. The present invention preferably uses baseband zero
18 crossing detections, which tend to be noisy detection when zero
19 crossing. However, the undesirable use of zero crossings producing
20 false or redundant transitions, and, the generation of an excessive
21 number of lead and lag signals, one for every window even when near
22 perfectly aligned, become insignificant, because the lead and lag
23 signal are generated regardless of the amount of phase offset
24 thereby providing canceling lead and lag signals during
25 accumulation. In effect, the present invention quickly and
26 accurately servos into perfect timing, despite noisy zero crossings
27 and despite an excessive number of lead and lag signal detections,
28 whereas, Marko adjusts the timing only when a large phase offset is

1 detected and repetitively detected as accumulated over many bit
2 periods, and as such, Marko's does not adjust for insignificant
3 timing errors and does not adjust unless significant errors are
4 detected over many bit periods. The present detects for de minimus
5 errors, and hence, does not need to accumulate large errors over
6 many bit periods. Because the lead and lag signals tend to equal
7 each other over time, accumulated lead and lag signals in near
8 perfect time alignment would not cause excessive adjustments over
9 time, but can adjust when very small errors occurs over a few bit
10 periods. The window comparison feature to generate lead and lag
11 signals allows for more precise timing and much faster timing
12 tracking that is well suited for multipath fading problems. Marko's
13 system does not generate lead and lag signals over a window time
14 and does not generate transition pulses from zero crossings.
15

16 Marko teaches that the recovered data boundaries are in 1/32
17 increments. As such, the transitions are not perfectly aligned in
18 time and timed to the baseband waveform signal, but rather, are
19 closely timed within 1/32 of the bit duration. The recovered data
20 signal and a recovered clock signal are phase detected for
21 generating early and late events that are accumulated. In
22 determining the early and late events, transitions of the recovered
23 clock are compared to transitions of recovered data. That is, two
24 digital streams are phase compared using respective transitions.
25 The recovery clock is used to sample the recovered data signal for
26 determining the data bit stream. When the accumulation of early or
27 late events occur, the recovery clock is adjusted by a reference
28 clock, so that, the recovery clock is more centered within a bit

1 duration of the recovered data so as to more precisely sample the
2 recovered data in the bit center for precisely generating the data
3 bit stream. The adjustment to the reference clock however is done
4 by dividing by either 31 or 33. That is, the recovery clock is also
5 adjusted by 1/32 duty cycle duration. The 1/32 bit boundaries of
6 the recovered data signal is a major error to precise bit timing.
7 The 1/32 duty cycle duration of the recovered clock is a minor
8 error to precise bit timing.

9

10 Significantly, the present invention generates positive and
11 negative transition pulses directly from the baseband waveform
12 signal preferably as the baseband waveform signal crosses zero. The
13 transition pulses are directly aligned in time to the transitions
14 of the baseband waveform signal, and as such, the transition pulses
15 are in fact synchronized to the baseband waveform signal. Because
16 the transition pulses are precisely aligned in time to the baseband
17 waveform signal and are thus synchronized to the baseband waveform
18 signal, there is no major error associated with the use of the
19 transition pulses relative to the baseband waveform.

20

21 These transition pulses detected as lead and lag signals
22 within a window are accumulated and the lead and lag accumulations
23 are immediately used to adjust the adjusted timing pulses. As such,
24 the present invention can adjust the adjusting timing pulses very
25 quickly, within a few bit periods, whereas, Marko would take an
26 indefinite amount of time, and at least the preferably 20 bit
27 periods of 20 successive early or late signals. The present
28 invention has a much faster response time, well suited for rapidly

1 changing environments, such as in the multipath fading environment
2 where a receiver passes tall buildings down town causing the signal
3 to move in time rapidly.

4

5 In the present invention, the transition pulses line up
6 exactly with transition of the baseband signal for improved data
7 detection. Marko's transitions are off as much as 1/32 of a bit
8 period. When the transitions are off less than this phase period,
9 no early and lag signals are generated. In the present invention,
10 lead and lags are determined over a window period regardless of how
11 much they are early or late, whereas, in Marko, the early and late
12 signals are generated from a phase offset. The use of zero crossing
13 detectors injects noise, but the counter is able to filter out
14 toggling leads and lags as the sum is zero over time.

15

16 One skilled in the art would not use window detection, which may
17 disadvantageously capture perfectly aligned transitions as
18 erroneous lead and lag signals. One skilled in the art would not
19 use zero crossings disadvantageously injecting noise and false
20 detections into the lead and lag determinations. However, the
21 benefit of such window detection and zero crossing detection
22 enables rapid determination of a misalignment between baseband
23 signal and the timing signal, regardless of how noisy the
24 transitions are and how small is the offset from perfection is the
25 time alignment. The invention would not have been obvious to
26 anyone.

27

Marko's tracking loop uses early and phase detection and accumulation providing minor timing errors, major timing errors, and adjustment to the timing only when many phase time period are accumulated providing slow and imprecise timing. The present invention using lead and lag window detection and accumulation without the minor and major timing error and make adjustment in the presence of very small timing error over a few bit periods and hence is more precise and tracks much faster.

10 Marko does not, in anyway remotely suggest zero crossing
11 transitions for generating lead and lag signals over a window
12 period for determining when to adjust the clocking signal. The
13 present invention, with a suitably size window time, will determine
14 that a transition leads or lag, regardless of by how much they are
15 early or late. As such, the present invention more quickly
16 generates multiple lead and lag signals for more quickly updating
17 the counter, and to more quickly adjust the timing pulses. This
18 case being in good condition for appeal or allowance, applicant
19 requests allowance of claims.

Respectfully Submitted

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